

Claims:

1. A motor control apparatus that drives and controls a motor, which is mounted on a vehicle and outputs power to a drive shaft linked to drive wheels, said motor control apparatus comprising:

an angular acceleration measurement module that measures an angular acceleration of either of said drive shaft and a rotating shaft of said motor;

10 a first skid detection module that detects a skid due to wheelspin of the drive wheels, based on the measured angular acceleration;

a first torque restriction control module that, in response to detection of a skid by said first skid detection module, restricts torque output and controls said motor with the restricted torque output, so as to reduce the skid;

a first integration module that integrates the angular acceleration, which is measured by said angular acceleration measurement module, to give a time integration thereof since detection of the skid by said first skid detection module; and

20 a first torque restoration control module that, in response to at least a reducing tendency of the skid, restores the torque output, which is restricted by said first torque

restriction control module, according to the time integration of the angular acceleration given by said first integration module and controls said motor with the restored torque output.

5 2. A motor control apparatus in accordance with claim 1, wherein said first skid detection module compares the angular acceleration measured by said angular acceleration measurement module with a preset threshold value to detect a skid, and

 said first integration module integrates the angular
10 acceleration over an integration interval when the measured angular acceleration once exceeds the preset threshold value and decreases again below the preset threshold value.

 3. A motor control apparatus in accordance with either
15 one of claims 1 and 2, wherein said first torque restoration control module varies a degree of restoration of the restricted torque output according to the time integration of the angular acceleration and controls said motor with the varied degree of the restored torque output.

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 4. A motor control apparatus in accordance with claim 3, wherein said first torque restoration control module controls said motor with a lower degree of restoration of the restricted

torque output against an increase in time integration of the angular acceleration.

5 5. A motor control apparatus in accordance with either one of claims 3 and 4, wherein said first torque restoration control module sets a maximum torque in restoration of the restricted torque output based on the time integration of the angular acceleration and controls said motor with the setting of the maximum torque as an upper limit.

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6. A motor control apparatus in accordance with any one of claims 1 through 5, wherein said first torque restoration control module restores the restricted torque output, in response to continuous measurement of a negative level of the angular acceleration for a preset time period by said angular acceleration measurement module, and controls said motor with the restored torque output.

20 7. A motor control apparatus in accordance with any one of claims 1 through 6, wherein said first torque restriction control module varies a degree of restriction of the torque output according to the measured angular acceleration and controls said motor with the varied degree of the restricted

torque output.

8. A motor control apparatus in accordance with claim 7,
wherein said first torque restriction control module controls
5 said motor with a higher degree of restriction of the torque
output against an increase in measured angular acceleration.

9. A motor control apparatus in accordance with either
one of claims 7 and 8, wherein said first torque restriction
10 control module sets a maximum torque in restriction of the
torque output based on the measured angular acceleration and
controls said motor with the setting of the maximum torque as
an upper limit.

15 10. A motor control apparatus in accordance with any one
of claims 1 through 9, wherein said vehicle has driven wheels
that are driven by the drive wheels,

said motor control apparatus further comprising:

a drive wheel rotation speed measurement module that
20 measures a rotation speed of the drive wheels;

a driven wheel rotation speed measurement module that
measures a rotation speed of the driven wheels;

a second skid detection module that detects a skid due

to wheelspin of the drive wheels, based on a wheel speed difference between the measured rotation speed of the drive wheels and the measured rotation speed of the driven wheels; and

5 a second torque restriction control module that, in response to detection of a skid by said second skid detection module, restricts the torque output and controls said motor with the restricted torque output, so as to reduce the skid.

10 11. A motor control apparatus in accordance with claim 10, said motor control apparatus further comprising:

 a second integration module that integrates the wheel speed difference between the measured rotation speed of the drive wheels and the measured rotation speed of the driven
15 wheels to give a time integration thereof since detection of the skid by said second skid detection module,

 wherein said second torque restriction control module restricts the torque output according to the time integration of the wheel speed difference and controls said motor with the
20 restricted torque output.

 12. A motor control apparatus in accordance with claim 11, wherein said second skid detection module compares the wheel

speed difference with a preset threshold value to detect a skid,
and

said second torque restriction control module restricts
the torque output according to the time integration of the wheel
5 speed difference since an increase in wheel speed difference
over the preset threshold value and controls said motor with
the restricted torque output.

13. A motor control apparatus in accordance with either
10 one of claims 11 and 12, wherein said second torque restriction
control module varies a degree of restriction of the torque
output according to the time integration of the wheel speed
difference and controls said motor with the varied degree of
the restricted torque output.

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14. A motor control apparatus in accordance with claim
13, wherein said second torque restriction control module
controls said motor with a higher degree of restriction of the
torque output against an increase in time integration of the
20 wheel speed difference.

15. A motor control apparatus in accordance with claim
12, said motor control apparatus further comprising:

a second torque restoration control module that, when a result of the comparison by said second skid detection module shows that the wheel speed difference decreases below the preset threshold value, restores the torque output restricted by said
5 second torque restriction control module and controls said motor with the restored torque output.

16. A vehicle equipped with a motor and a motor control apparatus in accordance with any one of claims 1 through 15.
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17. A motor control method that drives and controls a motor, which is mounted on a vehicle and outputs power to a drive shaft linked to drive wheels, said motor control method comprising the steps of:

15 (a) measuring an angular acceleration of either of said drive shaft and a rotating shaft of said motor;

(b) detecting a skid due to wheelspin of the drive wheels, based on the measured angular acceleration;

(c) in response to detection of a skid by said step (b),
20 restricting torque output and controlling said motor with the restricted torque output so as to reduce the skid;

(d) integrating the angular acceleration, which is measured by said step (a), to give a time integration thereof

since detection of the skid by said step (b); and

(e) in response to at least a reducing tendency of the skid, restoring the torque output, which is restricted by said step (c), according to the time integration of the angular
5 acceleration given by said step (d) and controlling said motor with the restored torque output.

18. A motor control method in accordance with claim 17, wherein said step (b) compares the angular acceleration
10 measured by said step (a) with a preset threshold value to detect a skid, and

said step (d) integrates the angular acceleration over an integration interval when the measured angular acceleration once exceeds the preset threshold value and decreases again
15 below the preset threshold value.

19. A motor control method in accordance with either one of claims 17 and 18, wherein said step (e) varies a degree of restoration of the torque output restricted by said step (c)
20 according to the time integration of the angular acceleration and controls said motor with the varied degree of the restored torque output.

20. A motor control method in accordance with claim 19, wherein said step (e) controls said motor with a lower degree of restoration of the restricted torque output against an increase in time integration of the angular acceleration.

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21. A motor control method in accordance with either one of claims 19 and 20, wherein said step (e) sets a maximum torque in restoration of the restricted torque output based on the time integration of the angular acceleration and controls said motor
10 with the setting of the maximum torque as an upper limit.

22. A motor control method in accordance with any one of claims 17 through 21, wherein said step (e) restores the restricted torque output, in response to continuous measurement
15 of a negative level of the angular acceleration for a preset time period by said step (a), and controls said motor with the restored torque output.